

# Water Resources and the Great Basin

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The Great Basin Watershed covers 362,600 km (140,110 mi<sup>2</sup>) and extends from the Sierra Nevada Range in California to the Wasatch Range in Utah, and from southeastern Oregon to southern Nevada (NBC Weather Plus Website). The region is among the driest in the nation and depends largely on winter snowfall and spring runoff for its water supply. Precipitation may be as much as 127 cm (50 inches) in high mountains, but many lower elevation desert areas receive only about 13 to 18 cm (5 to 7 inches) annually (State of Utah, Division of Water Resources webpage). Water supply can vary dramatically from year-to-year, and farms, cities, towns, and industries rely on the efficient use of reservoirs that capture spring snowmelt for distribution later in the year. When snow and rain are insufficient to fill reservoirs, farm yields are reduced, groundwater aquifers recede, and water restrictions can be imposed. Most of the region's water resources are fully appropriated with irrigation accounting for over 70 percent of water use in Nevada and Utah. As the region's population continues to grow, water is being converted from agricultural to urban use and groundwater sources are being used more extensively.

## Key Issues

*Population Growth*—The human population in the Great Basin is growing at among the highest rates in the Nation (Nevada #1; Utah #4 in the last census). Most of this growth is occurring around the urban communities of Salt Lake City, Carson City, and Las Vegas, which are located in the adjacent Lower Colorado Regional Watershed. The amount of water used by the public has steadily increased since the mid 1980s. Nevada's withdrawals for public supply have increased from 8 to 20 percent of total withdrawals (U.S. Geological Survey 1999) and growing urban areas are seeking additional water sources. One of the largest of these efforts is occurring in Nevada where the Southern Nevada Water Authority has proposed exporting groundwater from Clark, Lincoln, and White Pine counties to Las Vegas (Southern Nevada Water Authority 2007). A lack of scientific information

on the effects of these types of large-scale water projects is resulting in public controversy and complicating the decision-making process (Meyers and others 2006).

*Climate Change*—Ongoing climate change will have significant effects on the timing and amount of available water in this arid to semi-arid region (Wagner 2003, CIRMOUNT Committee 2006). Under warming trends, a larger fraction of precipitation will come as rain, and the region's snow packs will melt earlier, yielding higher winter and spring runoff rates and less summer runoff. Spring snowmelt is already occurring weeks earlier than in past decades and more precipitation falls as rain in much of the region. Continuation of these trends will result in increased winter floods in some basins, smaller warm-season reserves and rates of runoff, and warmer water temperatures in many of the region's rivers and lakes. In summer, lower flows coupled with higher variability may negatively affect various water uses including hydropower, irrigation, fish, and recreation. In winter, hydropower production could increase to take advantage of increased winter streamflow. Areas with increasing dryness will exhibit a decrease in groundwater recharge, decreasing the longevity of groundwater resources.

*Ecosystem Services*—Water resources provide ecosystem services that include not only an adequate supply of high quality water, but habitat for a diverse array of plants and animals (National Research Council 2001). Floodplains and riparian corridors serve as filters and buffers for upland ecosystems and habitat for wildlife, and can help mitigate flood effects. Natural flow regimes are necessary for maintaining channel dynamics, groundwater regimes, and native vegetation. Recognition of the importance of these ecosystem services has led to a paradigm shift where concerns about how much water can be reliably withdrawn have changed to concerns about how much water needs to be left in the river to support multiple uses.

*Water Storage and Water Deliver*—Water storage and the ability to control the timing of water deliveries for

beneficiaries continue to be critical issues (NBC Weather Plus website). In these arid to semi-arid ecosystems, water storage depends largely on snowmelt and is highly variable among years. Extreme climatic events, such as drought and floods, make consistent water delivery difficult and compound water quality problems in key sub-watersheds of the Great Basin. Loss of wetlands and riparian zones along river corridors also has diminished water quality. Water in reservoirs and streams is directly consumed by evapotranspiration and transpiration from irrigated crops and pasture land, natural vegetation, and water surfaces. Long-term environmental impacts from regional-scale ground-water extraction are a major concern. Dewatering of open pit mines to allow deep mining has resulted in significant inter-basin water transfers in large areas of northeastern Nevada.

*Water Diversion*—Throughout the Basin, water diversions have significantly altered lake levels and stream flows negatively affecting sediment regimes and water quality, decreasing streamside vegetation, and damaging or destroying fisheries and wildlife habitat. Low-head dams serve as barriers to flow and reduce river connectivity, which affects fish migration.

*Nonpoint source pollution*—Pollution due to agriculture has had a large impact on the quality of the Basin's water (NBC Weather Plus Website). Urban drainage systems also contribute nutrients, heavy metals and organic loads to the nonpoint source load. Persistent organic pollutants (POPs), such as polycyclic aromatic hydrocarbons (PAHs) and organic contaminants, are entering streams and water bodies through urban runoff and wastewater treatment plant discharges. To address these issues, Nonpoint Source Programs administered by the states are targeting the main pollutants of concern, principally temperature, pH, nutrients, salts, metals, and suspended solids (EPA 2007).

*Development*—Increased development along the region's rivers and lakes has resulted in increased sediment and nutrient loads in downstream areas (NBC Weather Plus Website). Lake Tahoe in the eastern Sierra Nevada has had a progressive decrease in the lake's clarity due to these factors. Programs to manage Lake Tahoe's water quality by regulating development and preventing pollutants from reaching the lake are being implemented at the federal, state, and local levels. The 1997 Presidential Forum for Lake Tahoe and government partnerships such as Tahoe Regreen are working toward solutions to forest health issues on the Eastern Sierra frontal range.

*Land use and land management activities*—Human activities and natural disturbances in the watersheds

affect both water quality and quantity. Over-grazing by livestock, mining, and roads can alter sediment regimes and negatively impact water quality. Vegetation type conversion can alter infiltration and runoff regimes and affect water supply.

## Management Challenges

Federal, state, and local governments are challenged to respond to a number of surface and ground water threats in the Great Basin through such activities as:

- Watershed planning and management for water supply, water quality, and stream corridors.
- Management of total maximum daily loads (TMDLs) of pollutants and persistent organic pollutants (POPs).
- Balancing urban growth and open space and agricultural land resources.
- Sustainable management of forest and rangeland resources for multiple uses.
- Increasing recreation opportunities while minimizing environmental impacts.
- Protection of biodiversity (for example, Cui-ui lake sucker and Lahonton Cutthroat Trout).
- Rehabilitation of unstable channels of major rivers and streams.
- Mitigation of impacts associated with development in flood plains of rivers and tributaries.
- Mitigation of river channel modifications and floodplain instability from diversion dams, channel straightening, and flood protection structures.

## Research and Management Questions

### *Water Resources and Uses*

What are the predicted rates of population increase and water consumption?

How are the diverse hydrological cycles and amounts of water in various forms of storage changing as a result of climate change?

How will changes in mountain snow packs as a result of climate change affect rural community and urban water supplies in the future?

What are the flow regimes and amounts required to maintain channel processes and support riparian and aquatic ecosystems?

What are the flow regimes and amounts required to support sensitive, threatened, and endangered species?

What are the effects of land use and land management on water quality and quantity and riparian areas and aquatic systems?

### ***Water Supply Options for the Future***

How can we improve use of existing water resources through use efficiency, new methods, and alternative operation of river-reservoir systems?

How do we expand water supply through treatment and increased use of lower quality water?

What alternatives are there for water storage?

### ***Predictive Tool***

How can we better predict the year-to-year variability in water resources?

How do we improve predictions of outcomes of storage, release, withdrawal, and use of water?

How can we better predict the outcomes of our planning and policy decisions?

How do we predict water needs/benefits for ecosystems and the impacts on other uses?

## **Existing Programs and Resources**

U.S. Geological Survey, Water Resources Program. Includes the Cooperative Water Program, National Streamflow Information Program, National Water Quality Assessment Program, Toxic Substances Hydrology Program, Ground Water Resources Program, Hydrologic Research and Development, State Water Resources Research Institute Program, and Water Information Coordination Program. <http://water.usgs.gov> [2007, July 17]

U.S. Environmental Protection Agency. Monitoring and Assessing Water Quality. 21 Mar. 2007. <http://www.epa.gov/owow/monitoring> [2007, June 17]

USDA Natural Resources Conservation Service, Snow Survey and Water Supply Forecasting. <http://www.nrcs.usda.gov/programs/snowsury> [2007, June 17]

The National Institutes for Water Resources. These institutes are located in each of the 50 states and are charged with research that fosters (1) the education of students and entry of research scientists into water resources fields; (2) research on water and water-related areas; and (3) the dissemination of research results to water managers and the public. Institutes are expected

to cooperate with other institutes and organization in the Region. Great Basin Institutes include:

Institute for Water and Watersheds. 2007. Oregon State University. <http://water.oregonstate.edu> [2007, July 17]

University of Idaho. Idaho Water Resources Research Institute. 5 Sept. 2005. <http://www.iwrri.uidaho.edu> [2007, July 17]

Desert Research Institute. Division of Hydrologic Sciences. <http://www.dhs.dri.edu> [2007, July 17]

Utah State University. Utah Center for Water Resources Research. 1 Mar. 2007. Utah State University. <http://www.engineering.usu.edu/uwrl/niwr> [2007, July 17]

### ***State Divisions of Water Resources.***

Idaho Department of Water Resources. 2002. <http://www.idwr.state.id.us> [2007, July 17]

State of Nevada. Department of Conservation and Natural Resources. Division of Water Resources. State of Nevada. Department of Conservation and Natural Resources. <http://www.water.nv.gov> [2007, July 17]

Oregon.gov. Water Resources Department. <http://www.wrd.state.or.us> [2007, July 17]

Utah.Gov. Division of Water Resources. 2005. Utah.Gov. <http://www.conservewater.utah.gov> [2007, July 17]

## **Strategic Plans**

State Water Plans are developed by each State's Divisions of Water Resources (see above).

## **References**

- CIRMOUNT Committee. 2006. Mapping new terrain: climate change and America's West. Report of the Consortium of Integrated Climate Research in Western Mountains (CIRMOUNT), Misc. Pub. PSW-MISC-77, Albany, CA, Pacific Southwest Research Station, Forest Service, U.S. Department of Agriculture, 29 p.
- Environmental Protection Agency. 2007. Monitoring and Assessing Water Quality. [Homepage of the Environmental Protection Agency], [Online]. Available: <http://www.epa.gov/owow/monitoring/> [2007, July 22].
- Meyers, T.; Burns, A.; Johnson, J. 2006. Point/Counterpoint: Nevada groundwater transfer: do we know enough to decide? *Southwest Hydrologist*. 5(3):14. Available: [http://www.swhydro.arizona.edu/archive/V5\\_N3/dept-pointcounterpoint.pdf](http://www.swhydro.arizona.edu/archive/V5_N3/dept-pointcounterpoint.pdf) [2007, July 17].
- National Research Council. 2001. Riparian areas: functions and strategies for management. National Academy Press. Washington, D.C. 444 p.
- NBC Weather Plus. National Watersheds: Great Basin. 2007. [Homepage of NBC4], [Online]. Available: [http://wrc.iewatershed.com/index.php?pagename=ow\\_regionalWatersheds\\_16](http://wrc.iewatershed.com/index.php?pagename=ow_regionalWatersheds_16) [2007, July 17].

- Wagner, F. H., ed. 2003. Preparing for a changing climate- the potential consequences of climate variability and change. Rocky Mountain/ Great Basin regional climate-change assessment. A report of the Rocky Mountain/Great Basin Regional Assessment Team for the U.S. Global Change Research Program. Utah State University, Logan, UT. 240 p.
- Southern Nevada Water Authority. 2007. Resources Plan. [Homepage of Southern Nevada Water Authority], [Online]. Available: [http://www.snwa.com/html/wr\\_resource\\_plan.html](http://www.snwa.com/html/wr_resource_plan.html) [2007, July 17].
- State of Utah 2007. Department of Natural Resources, Utah Division of Water Resources. Water Brochures. [Homepage of Utah Division of Water Resources], [Online]. Available: [http://water.utah.gov/Brochures/WIU\\_BROC.htm](http://water.utah.gov/Brochures/WIU_BROC.htm) [2007, July 17].
- U.S. Geological Survey. 1999. Nevada. USGS Fact Sheet 029-99. October 1999. 4 p.